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Research Article

BIOCHEMICAL STUDIES OF SOME PLANTS AFFECTED BY AIR POLLUTION IN JAMSHEDPUR, INDIA

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ABSTRACT
Being the home of one of the largest steel and iron company of the country and destination of many other well recognized industries, it becomes a necessity to evaluate the quality of air and its effect on the plants growing in Jamshedpur. Addition of thousands of private vehicles each year also adds up to the deterioration of ambient air quality. The present investigation is to evaluate the Impact of industrial and vehicular emission on some biochemical parameters of two tree species such as *Polyalthia longifolia* and *Azadirachta indica* growing along the roadside in different anthropogenic locations of Bistupur area at Jamshedpur, India. The biochemical parameters that were taken into consideration were total chlorophyll content, total carbohydrate content and total ascorbic acid content. Plant species differ in their response to air pollutants. Some acts as sink while other act as load. The total chlorophyll content, total carbohydrate content and ascorbic acid content in *Polyalthia longifolia* was higher in residential area as compared to the industrial and commercial areas. Similar result was seen in *Azadirachta indica* with an exceptional increase in the total carbohydrate content in the industrial and commercial areas as compared to the residential area. This work suggests that air pollutants emitted from automobiles and industries adversely affect the biochemical properties of the plants. It further suggests that plants can be used as cost effective biomonitoring tool to assess the quality of air we breathe in. this study is a pioneer in such an important industrial city of the country.

Keywords: *Air Pollution, Chlorophyll, Carbohydrate, Ascorbic Acid, Polyalthia Longifolia, Azadirachta Indica and Biomonitoring*

INTRODUCTION
Industrialization, rapid urbanization and tremendous increase in the number of vehicles on roads are contributing to a serious problem called as air pollution. The air pollutants destroy the atmospheric ozone shield that protects organisms from higher levels of UV radiation, resulting in global warming and climate change IPCC (2007). The crop plants and other plant species are very sensitive to gaseous and particulate pollutions and these can be used as indicator of air pollution. The ecological effects of roads and traffic have been reported by Spellerberg (1998) and Bignal *et al.*, (2004). Gratani *et al.*, (2000) reported positive relationships between traffic density and photosynthetic activity, stomatal conductance, total chlorophyll content and leaf senescence of *Quercus ilex* L. Kome. In urban environment trees play an important role in improving air quality by taking up gases and particles.
Plants take up the noxious air pollutants and act as a sink. Meanwhile, plants are continuously exposed to the chemical pollutants and injure the plants depending upon the intensity of these pollutants. Of all plant parts, leaf is the most sensitive part to air pollution Lalman and Singh (1990). Plants remove pollutants from air by 3 processes, namely deposition of particulates, absorption by leaves and aerosols over leaf surface Prajapati and Tripathi (2008).
Several studies have been carried out in India to highlight the effect of air pollution on biochemical parameters of different plant species at different places Pratibha and Sharma (2000); Ramakrishnaiah and Somashekhar (2003); Karthiyayini *et al.*, (2005); Gupta *et al.*, (2009). Air pollutants like SO_2, NO_2, SPM and RSPM are responsible for reduction of biological and physiological responses of various plants and crops grown at polluted area Joshi and Chauhan (2008) and Chauhan and Joshi (2008). In the present study, the biochemical parameters such as chlorophyll content, ascorbic acid content and carbohydrate

content were assessed the leaves of two common roadside plants *A. indica* and *P. longifolia* in Bistupur area of Jamshedpur, India.

MATERIALS AND METHODS

Study Area

The city of Jamshedpur is located at 22.8 degree N and 86.18 degree E. it has an average elevation of 135m (442 ft). It is an industrial city with different concentrations of air pollutants such as CO_2, SO_2, and nitrogen oxides. The major sources of air pollutants in Jamshedpur city are automobile exhaust, small and large industries and railway traffic.

Bistupur is one of the famous areas of Jamshedpur. It has commercial area and the India's largest iron and steel company (TISCO) is also located in this area. It also contains city's high profile residential area. Thus, depending upon the anthropogenic activities this area was divided into three experimental sites such as commercial site, industrial site and residential site.

Two commonly growing roadside plants growing in the experimental area were selected for study. These plants were *A. indica* and *P. longifolia*.

Sample Collection

The fresh leaves of the plants were plucked and brought to the laboratory for biochemical analysis.

Biochemical Analysis

Total chlorophyll content was estimated using the method of Singh *et al.,* (1991). In this method 200 mg of leaf sample was ground in a mortar and pestle with small quantity of acid washed sand and 80% acetone. The filtrate was collected and absorbance of the filtrate was measured through spectrophotometer at wavelength 645 nm and 663 nm. Total chlorophyll, was calculated using the formula of Arnon's equation (1949).

Chlorophyll a (mg/g) = ((12.7 * O.D. 663) – (2.69 * O.D. 645)) * V/1000 * W

Chlorophyll b (mg/g) = ((22.9 * O.D. 645) – (4.68 * O.D. 663)) * V/1000* W

Total Chlorophyll = Chlorophyll a + Chlorophyll b

Where:

V = total volume of extract

W = weight of leaves in grams

The ascorbic acid content was estimated by volumetric method using DCPIP (dichloro phenol indophenol). The formula used to calculate ascorbic acid content is given below:

Amount of Ascorbic Acid (mg/gm) = (0.5mg/V1 ml) * (V2 ml/5ml) * (100ml/weight of sample) * 100

Where:

V1 = Initial volume (Volume titrated by working standard)

V2 = Final Volume (Volume titrated by the sample)

The total carbohydrate content of leaves was estimated by phenol-sulphuric acid method. The formula used for calculating total carbohydrate content is given below:

100 ml of sample solution contains = x/0.1 X 100 mg of glucose

= _____% of total carbohydrate present.

Standard deviation and standard error were also calculated.

RESULTS AND DISCUSSION

Results

Table 1: Biochemical Analysis of Leaves of *Azadirachta indica*

Parameters	Industrial Area	Commercial Area	Residential Area
Chlorophyll Content (mg/g)	2.296±0.104	1.861±0.179	2.324±0.122
Ascorbic acid (mg/ml)	3.5±0.1	2.6±0.1	2.3±0.1
Total Carbohydrate Content(mg/ml)	0.71	0.67	0.65

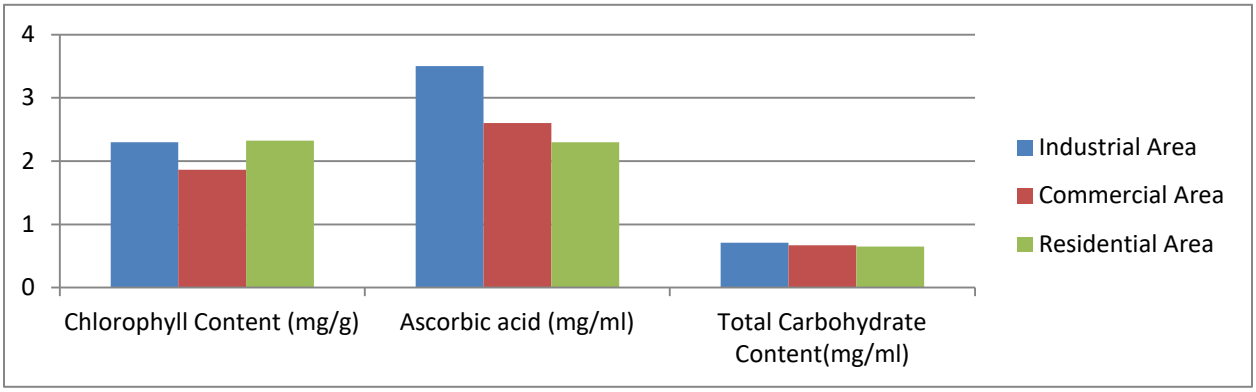

Figure 1: Biochemical Analysis of Leaves of *Azadirachta indica*

Table 2: Biochemical Analysis of Leaves of *Polyalthia longifolia*

Parameters	Industrial Area	Commercial Area	Residential Area
Chlorophyll Content (mg/g)	1.150±0.146	1.041±0.307	2.835±0.265
Ascorbic acid (mg/100ml)	2.64±0.2	1.264±0.00	3.7±0.2
Total Carbohydrate Content (mg/100ml)	0.54	0.83	1.62

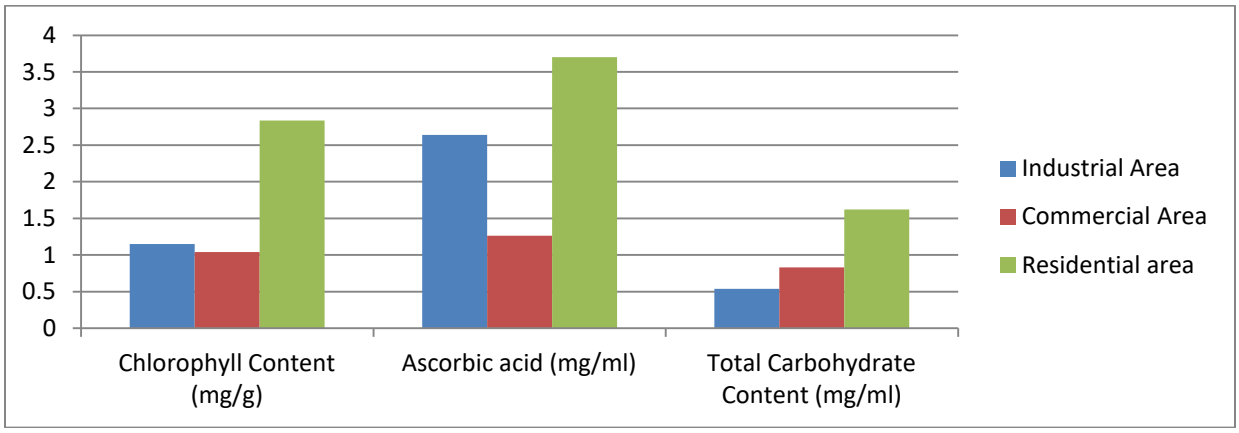

Figure 2: Biochemical Analysis of Leaves of *Polyalthia Longifolia*

Biochemical Analysis of A. indica

As shown in Table 1, Chlorophyll content of *A. indica* was maximum in residential area and minimum in commercial area. In case of ascorbic acid content, *A. indica* showed opposite results. Maximum ascorbic acid content was seen in the plants growing in industrial region and lowest in the residential region.

Biochemical Analysis of P. longifolia

Similar results were seen in case of total chlorophyll content in *P. longifolia*. Table 2 shows that total chlorophyll content is maximum in residential region and minimum in commercial region. Ascorbic Acid is maximum in residential region and minimum in commercial region. Total carbohydrate content is also maximum in residential region but minimum in industrial region.

Discussion

Changes in Chlorophyll Content

The most common impact of air pollution is the gradual loss of cholorophyll followed by yellowing of leaves which may be associated with damage caused in chloroplasts. This will lead to consequent decrease in the metabolic process of photosynthesis (Joshi & Swami, 2007). As the net photosynthesis rate is a direct indicator of air pollution (Woo *et al.*, 2007) and ultimately accumulated carbohydrates in the leaves and other parts of plant body, any variation positive or negative is the amount of total

carbohydrate is a strong indication of total carbohydrates variation with pigments in the leaves. The data obtained for pigments and total carbohydrates are thus, in complete agreement with this.

The enhanced air pollution level gives an impact on A. *indica* and P. *longifolia* as confirmed by a reduction in the total chlorophyll content from residential to industrial and commercial areas of Jamshedpur. The reddening effect on chlorophyll accounts for its conversion to carotenes which are photo-protective molecules saving the chlorophyll by defusing the extra pollutants. showed reduction in photosynthetic pigment as PSII gets damaged in sensitive species of tobacco. Chandawat *et al.*, (2011) observed that the cholorophyll content of all plants they tested varied with the pollution status of the area as well as the tolerance and sensitivity of the planned species. The present work on *A. indica* and *P. longifolia* showed are on the same line of agreement.

Changed in Ascorbic Acid

The role of ascorbate is no less an indicator because all the abiotic environmental stress due to air pollutants of plants. Since ascorbates has been shown as an efficient scavenger in the process of plant defense to various stresses. It participates directly in eliminating stress by playing as electron donor and enzymes involved in ascorbate metabolism also act positively in plant defense against various stresses. It protects the pigments against various stresses and oxidative damage. The total chlorophyll content is related to ascorbic acid productivity since the ascorbic acid is concentrated mainly in the chloroplasts (Liu and Ding, 2008). In the present study both the plants showed different results in the levels of ascorbic acid in different areas. *A. indica* increase showed in the ascorbic acid concentration in industrial reason as compared to commercial and residential reason while *P.longifolia* showed high ascorbic acid content in the residential area as compared to the industrial and commercials areas. This may be due to the tolerant nature of *A. indica* and sensitive nature of *P. longifolia* to air pollutants. Some plants exposed to air pollution are naturally adjusting to the gaseous pollutants by increasing these biochemical and physiological parameters in an attempt to contend with the environmental pollution (Nwadinigwe A.O., 2014). Nwadinigwe, A.O. (2014) also reported higher ascorbic acid content in plants from the polluted site than that from the control plants. Ascorbic acid is important in cell wall synthesis, defense and cell division. It is a strong reductant and it activates many physiological and defense mechanisms. It also plays an important role in photosynthetic carbon fixation.

High ascorbic acid activity is associated with rapidly expanding cells and regulates cell division thereby causing growth. It occurs in the cell wall, playing first line defense against air pollutants (such as SO_2) as observed by. Thus, chlorophyll and ascorbate are so interrelated in their effort to protect the plants. Plants have inbuilt capacity of adaptation to relieve from stress thereby plants survive only by adjusting the metabolites to certain limit beyond which the yellowing effect of leaves start indicating heavy pollution.

Changes in Total Carbohydrate Content

In the present study both the plants showed varying results. *A. indica* showed dramatic increase in the total carbohydrate content in the industrial area as compared to commercial and residential area while *P. longifolia* showed contrary results. The total carbohydrate content in case of *P. longifolia* decreased in industrial and commercial areas as compared to the residential area. This may be due to the tolerant nature of *A. indica* and sensitive nature of *P. longifolia*.

Some researched showed that concentration of total and soluble sugars decreased significantly in the sensitive trees. The decreases in total sugar content of damaged leaves probably corresponded with the photosynthesis inhibition or stimulation of respiration rate (Tzvetkova and Kolaro, 1996) while increase in amount of soluble sugar is a protective mechanism of leaves. Carbohydrate is a product of photosynthesis. It is an important storage material for plants. The level of chlorophyll and the amount of total carbohydrate present in leaf tissues indicate the photosynthetic efficiency of these plants. Tingey (1974) suggested that the retention of carbohydrate in leaves could cause reduction in photosynthesis by feedback inhibition and reduce the amount of assimilates for translocation to sinks within the plant.

Conclusion

All the three biochemical studies showed that *Azadirachta indica* adapted well to the changing concentrations of air pollutants in different study areas while *Polyalthia longifolia* failed to cope up with

this environmental stress. Biochemical analysis alone cannot justify the tolerant and sensitive characteristic feature of a plant. Air Pollution Tolerance Index should be calculated to actually know the tolerance and sensitivity levels of the plants. More work need to be done for a more conclusive result. This study just gives a rough idea that *A. indica* may be a tolerant plant species and *P. longifolia* as a sensitive species.

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